

CLAIMS

What is claimed is:

- 1 1. A method for singulating dice from a substrate comprising:
 - 2 forming one or more grooves in a first side of the substrate between adjacent
 - 3 dice;
 - 4 coupling a second side of the substrate opposite the first side to a flexible
 - 5 diaphragm; and
 - 6 applying a fluid pressure differential between the first side and the
 - 7 diaphragm sufficient to cause the diaphragm to bow and cause substrate fracture
 - 8 along the grooves forming singulated dice.
- 1 2. The method of claim 1 wherein coupling a second side to a diaphragm
2 comprises:
 - 3 adhesively coupling a second side to a central portion of a flexible
 - 4 diaphragm defining a perimeter tab of the flexible diaphragm extending beyond and
 - 5 around a perimeter edge of the substrate; and
 - 6 coupling the tab around the perimeter edge in fluid tight engagement to a
 - 7 mounting flange of a pressure frame, the pressure frame and coupled diaphragm
 - 8 defining a cavity adapted to provide a fluid pressure differential with the ambient
 - 9 pressure, the pressure frame further comprising a pressure port in fluid
 - 10 communication with the cavity adapted to communicate with a fluid pressure
 - 11 source.
- 1 3. The method of claim 2 wherein coupling the tab around the perimeter edge
2 comprises coupling the tab around the perimeter edge, the substrate being exterior to
- 3 the cavity.
- 1 4. The die singulation method of claim 3 wherein applying a fluid pressure
2 differential comprises raising the fluid pressure in the cavity above the ambient
- 3 pressure exterior to the cavity causing the diaphragm to outwardly bow.

1 5. The method of claim 1 wherein coupling a second side of the substrate to a
2 flexible diaphragm comprises:

3 coupling a second side of the substrate to a diaphragm comprising elastic
4 properties wherein the diaphragm returns to substantially an original state upon
5 withdrawal of the fluid pressure differential.

1 6. The method of claim 1 wherein forming one or more grooves in a first side
2 of the substrate between adjacent dice comprises:

3 aiming and scanning a laser beam across a first substrate side between
4 adjacent dice, the laser beam having sufficient energy for forming the one or more
5 grooves through ablation.

1 7. The method of claim 1 wherein forming one or more grooves in a first side
2 of the substrate between adjacent dice comprises:

3 scribing across the first side between adjacent dice.

1 8. The method of claim 7 wherein scribing is a process selected from the group
2 consisting of:

3 moving a selected one of a vibrating needle, a non-vibrating needle, a
4 grinding bit, and a blade against the first side so as to form the one or more grooves
5 thereon; and

6 cutting into the first side using a rotating or reciprocating saw blade to form
7 the one or more grooves thereon.

1 9. The method of claim 1 further comprising:

2 removing the singulated dice from the flexible diaphragm.

1 10. The method of claim 1 wherein raising the fluid pressure in the cavity above
2 the ambient pressure exterior to the cavity comprises:

3 filling the cavity with a fluid at an elevated pressure relative to the ambient
4 pressure exterior to the cavity, the fluid selected from a group consisting of liquid
5 and gas.

1 11. The method of claim 1 wherein forming one or more grooves in a first side
2 of the substrate between adjacent dice comprises:

3 forming one or more grooves in a first side of the substrate between adjacent
4 dice sufficient to form crystal defects within the substrate, sufficient to form a
5 location for fracture initiation to facilitate fracture about a crystal plane.

1 12. The method of claim 1 wherein:

2 forming one or more grooves in a first side of the substrate between adjacent
3 dice, comprises aiming and scanning a laser beam across a first substrate side
4 between adjacent dice, the laser beam having sufficient energy for forming the one
5 or more grooves through ablation;

6 coupling a second side of the substrate opposite the first side to a flexible
7 diaphragm comprises, adhesively coupling a second side to a central portion of a
8 flexible diaphragm defining a perimeter tab of the flexible diaphragm extending
9 beyond and around a perimeter edge of the substrate;

10 wherein coupling the tab around the perimeter edge in fluid tight
11 engagement to a mounting flange of a pressure frame, the pressure frame and
12 coupled diaphragm defining a cavity adapted to provide a fluid pressure differential
13 with the ambient pressure, the pressure frame further comprising a pressure port in
14 fluid communication with the cavity adapted to communicate with a fluid pressure
15 source; and

16 wherein applying a fluid pressure differential between the first side and the
17 diaphragm sufficient to cause the diaphragm to bow and cause substrate fracture
18 along the grooves forming singulated die comprises, raising the fluid pressure in the
19 cavity above the ambient pressure exterior the cavity causing the diaphragm to
20 outwardly bow.

1 13. A microelectronic device packaging method, comprising:
2 forming one or more grooves in a first side of a substrate between adjacent
3 dice;
4 coupling a second side of the substrate opposite the first side to a flexible
5 diaphragm;
6 applying a fluid pressure differential between the first side and the
7 diaphragm sufficient to cause the diaphragm to bow and cause substrate fracture
8 along the grooves forming singulated dice;
9 removing the singulated dice from the diaphragm; and
10 interconnecting at least one die onto a carrier substrate.

1 14. The method of claim 13 wherein coupling a second side to a diaphragm
2 comprises:
3 adhesively coupling a second side to a central portion of a flexible
4 diaphragm defining a perimeter tab of the flexible diaphragm extending beyond and
5 around a perimeter edge of the substrate; and
6 coupling the tab around the perimeter edge in fluid tight engagement to a
7 mounting flange of a pressure frame, the pressure frame and coupled diaphragm
8 defining a cavity adapted to provide a fluid pressure differential with the ambient
9 pressure, the pressure frame further comprising a pressure port in fluid
10 communication with the cavity adapted to communicate with a fluid pressure
11 source.

1 15. The method of claim 14 wherein coupling the tab around the perimeter edge
2 comprises coupling the tab around the perimeter edge, the substrate being exterior to
3 the cavity.

1 16. The die singulation method of claim 15 wherein applying a fluid pressure
2 differential comprises raising the fluid pressure in the cavity above the ambient
3 pressure exterior to the cavity causing the diaphragm to outwardly bow.

1 17. The method of claim 13 wherein coupling a second side of the substrate to a
2 flexible diaphragm comprises:

3 coupling a second side of the substrate to a diaphragm comprising elastic
4 properties wherein the diaphragm returns to substantially an original state upon
5 withdrawal of the fluid pressure differential.

1 18. The method of claim 13 wherein forming one or more grooves in a first side
2 of the substrate between adjacent dice comprises:

3 aiming and scanning a laser beam across a first substrate side between
4 adjacent dice, the laser beam having sufficient energy for forming the one or more
5 grooves through ablation.

1 19. The method of claim 13 wherein forming one or more grooves in a first side
2 of the substrate between adjacent dice comprises:

3 scribing across the first side between adjacent dice.

1 20. The method of claim 19 wherein scribing is a process selected from the
2 group consisting of:

3 moving a selected one of a vibrating needle, a non-vibrating needle, a
4 grinding bit, and a blade against the first side so as to form the one or more grooves
5 thereon; and

6 cutting into the first side using a rotating or reciprocating saw blade to form
7 the one or more grooves thereon.

1 21. The method of claim 13 further comprising:

2 removing the singulated dice from the flexible diaphragm.

1 22. The method of claim 13 wherein raising the fluid pressure in the cavity
2 above the ambient pressure exterior the cavity comprises:

3 filling the cavity with a fluid at an elevated pressure relative to the ambient
4 pressure exterior to the cavity, the fluid selected from the group consisting of liquid
5 and gas.

1 23. The method of claim 13 wherein forming one or more grooves in a first side
2 of the substrate between adjacent die comprises:

3 forming one or more grooves in a first side of the substrate between adjacent
4 dice sufficient to form crystal defects within the substrate, sufficient to form a
5 location for fracture initiation to facilitate fracture about a crystal plane.

1 24. The method of claim 13 wherein:

2 forming one or more grooves in a first side of the substrate between adjacent
3 dice, comprises aiming and scanning a laser beam across a first substrate side
4 between adjacent dice, the laser beam having sufficient energy for forming the one
5 or more grooves through ablation;

6 coupling a second side of the substrate opposite the first side to a flexible
7 diaphragm comprises, adhesively coupling a second side to a central portion of a
8 flexible diaphragm defining a perimeter tab of the flexible diaphragm extending
9 beyond and around a perimeter edge of the substrate;

10 wherein coupling the tab around the perimeter edge in fluid tight
11 engagement to a mounting flange of a pressure frame, the pressure frame and
12 coupled diaphragm defining a cavity adapted to provide a fluid pressure differential
13 with the ambient pressure, the pressure frame further comprising a pressure port in
14 fluid communication with the cavity adapted to communicate with a fluid pressure
15 source; and

16 wherein applying a fluid pressure differential between the first side and the
17 diaphragm sufficient to cause the diaphragm to bow and cause substrate fracture
18 along the grooves forming singulated die comprises, raising the fluid pressure in the
19 cavity above the ambient pressure exterior to the cavity causing the diaphragm to
20 outwardly bow.

1 25. An apparatus for singulating dice from a substrate, comprising:
2 a flexible diaphragm defining a perimeter tab of a size adapted to extend
3 beyond and around a perimeter edge of the substrate; and
4 a pressure frame comprising a mounting flange in fluid tight engagement
5 with the perimeter tab, the pressure frame and flexible diaphragm defining a cavity
6 therebetween, the pressure frame further comprising a pressure port in fluid
7 communication with the cavity adapted to communicate with a fluid pressure
8 source.

1 26. The apparatus of claim 25, wherein the flexible diaphragm comprises a
2 material selected from the group consisting of flexible material, substantially
3 inelastic cloth, substantially elastic cloth, and substantially elastic polymeric
4 material. .

1 27. The apparatus of claim 25, wherein the pressure frame comprises a flat plate
2 having an aperture there through, the mounting flange defined by the plate
3 encircling the perimeter of the aperture.

1 28. The apparatus of claim 25, the pressure frame further comprises a base plate,
2 wherein the mounting flange extends a predetermined distance from the base plate,
3 the mounting flange terminating in a rim, the rim in fluid tight engagement with the
4 perimeter tab.

1 29. The apparatus of claim 28, further comprising a ring clamp, the ring clamp
2 in urging engagement with the mounting flange with the perimeter tab there
3 between.